View metadata, citation and similar papers at core.ac.uk

brought to you by CORE

ACTA
STOMATOLOGICA
CROATICA
www.ascro.hr

Acta stomatol Croat. 2017;51(4):290-299.
DOI: 10.15644/asc51/4/3

IZVORNI ZNANSTVENI RAD
ORIGINAL SCIENTIFIC PAPER

Jozo Badrov[1], Goran Gašpar[1], Antonija Tadin[1], Tea Galić[1], Danijela Kalibović Govorko[1], Lidija Gavić[1], Robert Badrov[1], Ivan Galić[1,2]

Prevalencija i vrsta hipodoncije kod ortodontskih pacijenata u južnoj Hrvatskoj

Prevalence and Characteristics of Congenitally Missing Permanent Teeth among Orthodontic Patients in Southern Croatia

[1] Studij dentalne medicine Medicinskog fakulteta Sveučilišta u Splitu
Study of Dental Medicine, University of Split School of Medicine, Split, Croatia
[2] Katedra za istraživanje u biomedicini i zdravstvu Medicinskog fakulteta Sveučilišta u Splitu
Department of Research in Biomedicine and Health, University of Split School of Medicine, Split, Croatia

Sažetak

Cilj: Prirođeni manjak trajnih zuba ili hipodoncija prepoznat je kao klinički i javnozdravstveni problem u dječjoj dentalnoj medicini i ortodonciji. Istražiti prevalenciju hipodoncije u južnoj Hrvatskoj. **Materijali i postupci:** U retrospektivnom istraživanju analizirali smo hipodonciju trajnih zuba, neuključujući treće kutnjake, u ispitanika iz triju različitih geografskih područja u južnoj Hrvatskoj. Odabrane su dvije specijalističke ordinacije iz svake zemljopisne regije i obuhvaćeno je ukupno 4649 ispitanika u dobi od 6 do 15 godina, te su svi pregledani između 2008. i 2015. godine. Nakon što je isključeno 219 ispitanika, u istraživanju ih je ostalo 4430. **Rezultati:** Nije bilo statistički značajne razlike u prevalenciji hipodoncije između geografskih područja pa je analiziran cjelokupni uzorak. Od hipodoncije je patilo 345 (7,8 %) ispitanika. Najviše je bilo onih s manjkom jednoga i dvaju zuba – 122 (81,9 %) muška i 158 (80,6 %) ženskih ispitanika, a zatim slijede oni bez tri do pet zuba – 25 (16,8 %) muških i 35 (17,9 %) ženskih ispitanika. Pojavnost obostrane hipodoncije drugih donjih pretkutnjaka i drugih gornjih sjekutića bila je veća od jednostrane. **Zaključak:** Rezultati prevalencije hipodoncije u južnoj Hrvatskoj upućuju na potrebu pravodobne dijagnostike kako bi se na vrijeme počelo s terapijom umjerenih i teških slučajeva.

Zaprimljen: 8. kolovoza 2017.
Prihvaćen: 16. listopada 2017.

Adresa za dopisivanje
Doc. dr. sc. Ivan Galić
Sveučilište u Splitu
Medicinski fakultet
Šoltanska 2, 21 000 Split, Hrvatska
tel: 385-99-69-64-609
i_galic@yahoo.com

Ključne riječi
anodoncija; prevalencija; Hrvatska

Uvod

Prirođeni nedostatak trajnih zuba (congenitally missing permanent teeth – CMPT) ili hipodoncija klinički je i javnozdravstveni problem u dentalnoj medicini (1). CMPT se povezuje s određenim sindromima i stanjima kao što su Downov sindrom, ektodermalna displazija te rascijepi usne i nepca (2 – 4). Etiologija nesindromskih i obiteljskih CMPT-a prepoznata je kao višefaktorska te uključuje mutacije pojedinih gena kao što su AXIN2, MSX1, PAX9, WNT10A (5 – 8). Osobe s hipodoncijom mogu imati istaknute promjene u orofacijalnom sustavu, kao što su nepravilna artikulacija, infraokluzija i smanjen kapacitet žvakanja. Dodatno može biti naglašeno nezadovoljstvo estetskim izgledom koje može utjecati na njihovo samopouzdanje, buduće napredovanje i karijeru (1, 9, 10). Razvoj trajnih zuba, neuključujući treće kutnjake, može trajati sve do 15 godina, ali vrlo je važno CMPT uočiti u ranom djetinjstvu tijekom izmjene mliječne i trajne denticije, između 7. i 9. godine, kako bi se moglo pravilno intervenirati prije nego što dijete vidi razliku u odnosu na vršnjake (9, 11). Trajanje i cijena liječenja hipodoncije ovisi o stadiju izraženosti, tj. o uku-

Introduction

Hypodontia or congenitally missing permanent teeth (CMPT) is recognized as a clinical and public health problem in dental medicine (1). CMPT is commonly associated with specific syndromes and conditions such as Down's syndrome, ectodermal dysplasia and cleft lip and palate (2-4). The etiology of non-syndromic and familial CMPT is unidentified and multifactorial, including mutations of candidate genes, *AXIN2, MSX1, PAX9, WNT10A* (5-8). Patients with hypodontia may suffer from inappropriate articulation, infra-occlusion, reduced chewing capacity and poor esthetic appearance which can affect their self-esteem and professional performance (1, 9, 10). The timing of development of permanent teeth, excluding third molars, can occur up to 15 years of age. However, it is vital to recognize CMPT in early childhood, if possible at the age of 7 - 9 years, to properly treat it, even before the child recognizes the differences compared to his/her peers (9, 11). Duration and cost of the CMPT treatment depend on the severity and position of the missing teeth (1). Also, therapy may be a severe financial burden for orthodontic patients and their families (12).

pnom broju i poziciji u luku zuba koji nedostaju (1). Složeno i dugotrajno ortodontsko i protetičko liječenje može biti velik financijski teret pacijentima i njihovim obiteljima (12).

Prevalencija hipodoncije trajnih zuba istraživala se u mnogim populacijama, što se može vidjeti iz dosadašnjih sustavnih pregleda i metaanaliza (13 – 15). Nedavna metaanaliza, bazirana na radovima objavljenima od 2002. do 2012. godine, navodi srednju prevalenciju hipdodoncija u Europi od sedam posto [95 % interval pouzdanosti, 6 % do 8 % (15)]. Najveća razlika u prevalenciji hipodoncije između populacija bila je gotovo 38 puta – u izraelskom istraživanju iznosila je 0,3 posto nasuprot slovenskom ili irskom od 13,6 posto (16). Više nacionalnih populacijskih studija pokazalo je značajnu razliku u prevalenciji hipodoncije u različitim regijama unutar iste države. Legović i suradnici (17) usporedili su dvije regije u Hrvatskoj, Aktan i suradnici (18) to su učinili u šest regija u Turskoj, a Behr i suradnici (1) usporedili su više regija u okolici grada Regensburga u Njemačkoj. Posljednja istraživanja o prevalenciji hipodoncije u Hrvatskoj objavljena su prije 20 godina (19 – 21).

Svrha ovog istraživanja bila je odrediti prevalenciju hipodoncije trajnih zuba, u ortodontskih pacijenata u različitim regijama južne Hrvatske (grad Split, priobalje i kontinentalna regija) s populacijom od 455 tisuća stanovnika prema popisu iz 2011. godine (22). Pretpostavili smo da nema razlike između različitih regija u južnoj Hrvatskoj i da je prevalencija hipodoncije u rasponu rezultata za Europljane objavljenih u suvremenoj literaturi (13, 15).

Materijali i postupci

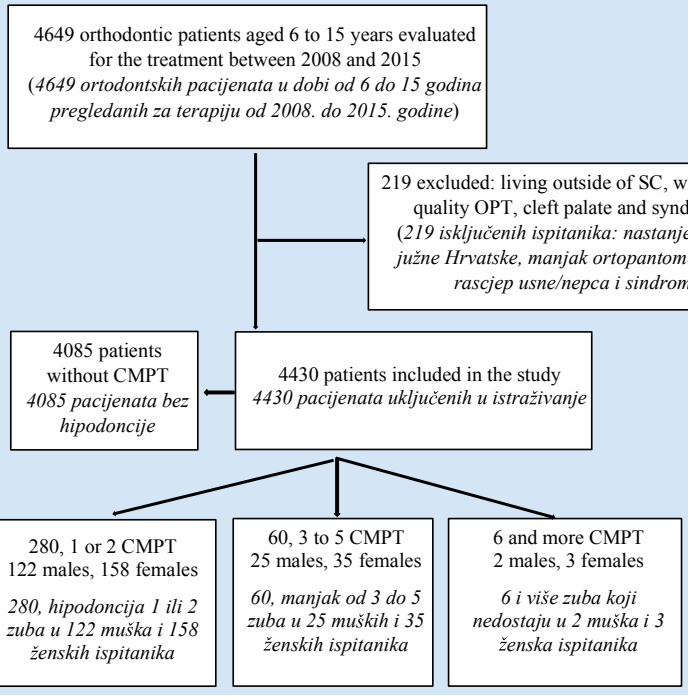
Ovo retrospektivno presječno istraživanje obuhvatilo je sve ortodontske pacijente u dobi od 6 do 15 godina, obrađene i klinički pregledane u šest ortodontskih ordinacija u južnoj Hrvatskoj, u razdoblju od 2008. do sredine 2015. godi-

Systematic reviews and meta-analyses extensively studied the prevalence of CMPT in different populations (13-15). The most recent meta-analyses showed the prevalence of CMPT in Europe of 7.0% (95% confidence interval 6.0% to 8.0%), based on studies published from 2002 to 2012 (15). The reported population differences in the prevalence of CMPT were almost 38 fold, i.e., Israeli 0.3 % vs. Slovenian or Irish 13.6 % (16). Few national population studies showed significant differences in the prevalence of CMPT in different regions. Legovic et al. (17) compared two areas in Croatia, Aktan et al. (18) examined six regions in Turkey, while Behr et al. (1) studied different regions around Regensburg in Germany. Previous studies on the prevalence of CMPT in Croatia were performed twenty years ago (19-21). Hence, the present study aimed to examine the prevalence of CMPT among orthodontic patients in different regions of Southern Croatia (i.e., Town of Split, littoral region, and continental region) with the population of 455, 000 according to 2011 census (22).

We hypothesized that there is no difference among different regions of Southern Croatia and that the frequency of CMPT corresponds to the frequency interval for Europeans, which was published in the contemporary literature (13, 15).

Materials and Methods

This retrospective cross-sectional study included all orthodontic patients aged 6-15 years recorded and clinically examined in six orthodontic practices (OP) in Southern Croatia, during the period between 2008 and mid-2015. Two



Slika 1. Dijagram s brojem ispitanika uključenih u istraživanje
Figure 1 Flowchart showing the number and distribution of participants with congenitally missing permanent teeth (CMPT) through the study

ne. Dvije ordinacije bile su u najvećem gradu južne Hrvatske – u Splitu, druge dvije u priobalnim središtima, a preostale dvije u pretežito kontinentalnom dijelu. Pregledane su baze podataka u svakoj ordinaciji, kartoni dentalnog i ortodontskog liječenja, povezane medicinske bilješke pojedinih postupaka i ortopantomogrami. Podatci za analizu uključivali su datum rođenja, spol, trajnu adresu prebivališta, specifičan tip i ukupan broj trajnih zuba koji nedostaju ispitaniku s hipodoncijom. Treći kutnjaci, uključujući i njihov nedostatak, nisu procjenjivani.

Od ukupno 4649 ortodontskih pacijenata, iz istraživanja su isključeni oni s trajnim prebivalištem izvan južne Hrvatske, s nepotpunim dentalnim podatcima, bez ortopantomograma ili s ortopantomogramom loše kvalitete. Dodatni kriteriji za isključenje bili su rascijepi usne i nepca, prirođeni sindromi i stanja povezana s hipodoncijom (slika 1.).

Svi ortopantomogrami snimljeni su za daljnju analizu u formatu Joint Photographic Experts Group (JPG). Analizu ortopantomograma i detekciju hipodoncije obavila su dva istraživača, specijalista oralne kirurgije – J.B. i I.G. Unutaristraživačka i međuistraživačka ponovljivost u detekciji broja zuba koji nedostaju izračunata je i izražena koeficijentom kappa.

U konačnom uzorku od 4430 ortodontskih pacijenata u dobi između 6 i 15 godina, ortopantomogrami su podijeljeni u skupine prema težini hipodoncije. Blaga hipodoncija definirana je kao nedostatak jednoga ili dvaju trajnih zuba, umjerena kao nedostatak od tri do pet trajnih zuba, a slučajevi kada nedostaje više od šest zuba definirani su kao teška hipodoncija ili oligodoncija (1).

MS excel 2010. (Microsoft Office 2010., Microsoft, Redmond, WA) i SPSS Statistics 17.0 za Windowse (SPSS inc., Chicago, IL, SAD) upotrijebljeni su za obradu podataka i statističku analizu. Hi-kvadratni test korišten je za vrjednovanje razlike u prevalenciji između triju urbanih zona. Razlike između spolova, lijeve i desne strane čeljusti te antagonističkih čeljusti izračunate su 2-by-2 tablicom i prikazane kao vjerojatnosti (ORs), uključujući i 95-postotni raspon pouzdanosti (95 % CI) (8). Statistička značajnost postavljena je na 0,05.

Rezultati

Ispitivačeva i međuispitivačka pouzdanost detekcije ortopantomograma s hipodoncijom bila je maksimalna (Cohenov kappa = 1,0). Konačni uzorak za analizu sastojao se od 4430 ortopantomograma ispitanika u dobi od 6 do 15 godina. Od ukupnog broja snimaka, 4085 bilo je bez hipodoncije (92,2,%), a 345 (7,8 %) ispitanika imalo je hipodonciju (slika 1.). Srednja dob pacijenata bila je 10,6 ± 2,1 godina. Distribucija prema dobnim skupinama i spolu prikazana je u tablici 1.

Među muškarcima su 62 od 722 (8,6 %) ispitanika s hipodoncijom bila iz grada Splita, 50 od 781 (6,4 %) iz priobalja te 37 od 648 (5,7 %) iz kontinentalnog područja. Kad je riječ o ženama, 70 od 712 (9,8 %) pacijentica s CMPT-om bilo je iz Splita, 58 od 690 (8,4 %) iz priobalja i 68 od 532 (12,8 %) iz kontinentalnog područja. Nije postojala statistički značajna razlika u prevalenciji hipodoncije između različi-

practices were located in the capital town of Southern Croatia, the city of Split; other two were placed in regional urban cities in the littoral region, and the last two in the dominantly continental region. Databases in each OP, which integrated dental and orthodontic treatment history, related medical and panoramic radiographs (OPT), casts, and additional treatment records, were used to evaluate patients. The data for analysis included the date of birth and OPT, gender, permanent residential address, the specific type and the total number of missing permanent teeth in each participant with CMPT. Third molars, including their absence, were not evaluated. Among 4649 orthodontic patients, those who permanently lived outside Southern Croatia, with the incomplete dental record, without OPT or low-quality OTP in the database, were excluded from the study. Additional exclusion criteria were cleft lip and palate, congenital syndromes and conditions related to CMPT (Figure 1). All OPTs were recorded in JPG format for further analysis. Two authors performed observation of OTPs and detection of CMPT, JB and IG, and Kappa coefficients were calculated.

In the final sample of 4430 orthodontic patients aged 6-15 years, OPTs were divided into groups according to the severity of CMPT. Mild hypodontia was defined if one or two teeth were missing, moderate hypodontia if there were three to five missing teeth, and cases of six or more missing teeth were described as severe hypodontia or oligodontia (1).

MS Excel 2010 (Microsoft Office 2010, Microsoft, Redmond, WA) and SPSS Statistics 17.0 for Windows (SPSS Inc., Chicago, IL) were used for data management and statistical analysis. Chi-square test was used to evaluate the prevalence differences among different urban zones. The differences between sexes, sides of the jaw and opposing jaws were calculated using 2-by-2 tables and presented by odds ratios (ORs) including 95% confidence intervals (95% CI) (1). Statistical significance was set to 0.05.

Results

The intra-observer and interobserver agreements for the first and second observer in detecting OPTs with CMPT were completed (Cohen Kappa = 1.0). The final sample for evaluation consisted of 4430 participants aged 6 - 15 years. 4085 participants were with no CMPT (92.2%), while 345 (7.8%) participants were with CMPT (Figure 1). The mean age of the patients was 10.6±2.1 years. Table 1 shows age and sex distribution of the study sample.

In males, 62 of 722 (8.6%), 50 of 781 (6.4%) and 37 of 648 (5.7%), and in females 70 of 712 (9.8%), 58 of 690 (8.4%) and 68 of 532 (12.8%) patients with CMPT were found in the city of Split, littoral and continental regions, respectively. There was no statistically significant difference in prevalence of CMPT among different regions in males, χ^2 (2, 2300) =4.25, (p =0.119), and in females, χ^2 (2, 2130) =5.20, (p =0.074). Therefore, we evaluated the whole

www.ascro.hr

Tablica 1. Raspodjela ispitanika s hipodoncijom i ukupnog uzorka prema dobnim skupinama
Table 1 Distribution of participants with congenitally missing permanent teeth (CMPT) and evaluated sample across different age groups

Dobne skupine (godine) • Age group (years)	Muškarci • Males			Žene • Females			Ukupno • Total		
	N_{CMT}	N	%	N_{CMT}	N	%	N_{CMT}	N	%
6.0 - 6.9	4	46	8.7	3	54	5.6	7	100	7.0
7.0 - 7.9	13	168	7.7	18	72	25.0	31	240	12.9
8.0 - 8.9	27	150	18.0	26	149	17.4	53	299	17.7
9.0 – 9.9	15	315	4.8	32	167	19.2	47	482	9.8
10.0 – 10.9	21	390	5.4	35	328	10.7	56	718	7.8
11.0 – 11.9	26	286	9.1	33	408	8.1	59	694	8.5
12.0 – 12.0	21	200	10.5	22	400	5.5	43	600	7.2
13.0 – 13.9	12	588	2.0	16	268	6.0	28	856	3.3
14.0 – 14.0	8	117	6.8	7	216	3.2	15	333	4.5
15.0 – 15.9	2	40	5.0	4	68	5.9	6	108	5.6
Ukupno • Total	149	2300	6.5	196	2130	9.2	345	4430	7.8

N_{CMPT} = broj ispitanika s hipodoncijom • number of participants with CMPT; N = ukupan broj ispitanika • total number of participants.

tih područja, kako u muškog spola – χ^2 (2, 2300) = 4,25 (p = 0,119), tako i u ženskoga – χ^2 (2, 2130) = 5,20; (p =0,074). S obzirom na to da nije bilo razlike između područja, dalje smo analizirali cjelokupni uzorak, posebno za muški i ženski spol.

Ukupno prevalencija hipodoncije u ispitanom uzorku bila je veća u žena (9,2 %) u usporedbi s muškarcima (6,4 %) – OR = 1,42 (95 % CI, 1,14 do 1,77), (p = 0,002). Blagi, umjereni i teški oblici hipodoncije bili su jednako raspoređeni između muškoga i ženskoga spola, bez statistički značajne razlike. Broj i udjel ispitanika s manjkom jednoga trajnog zuba u našem uzorku bio je 66 (44,3 %) kod muškog spola i 83 (42,3 %) kod ženskog spola, a bez dvaju trajnih zuba bilo je 56 (37,6 %) muškaraca i 75 (38,3 %) žena. Obostrana hipodoncija drugoga donjeg pretkutnjaka i drugoga gornjeg sjekutića bila je češća od jednostrane. Nadalje, u skupini s umjerenom hipodoncijom, ili kod ispitanika s tri do pet trajnih zuba koji im nedostaju, bilo je 11 (7,4 %) pacijenata i 15 (7,7 %) pacijentica s manjkom od tri zuba, 10 (6,7 %) pacijenata i 16 (8,2 %) pacijentica s manjkom od četiri zuba te četiri (2,7 %) pacijenta i četiri (2,0 %) pacijentice s manjkom od pet zuba. Teški oblici hipodoncije ili oligodoncije bili su raspoređeni na sljedeći način: manjak od šest zuba pronađen je kod dviju osoba ženskoga spola, osam zuba nedostajalo je dvojici muškaraca, te 11 zuba jednom muškarcu (tablica 2.).

Prema udjelu ukupnog broja zuba koji nedostaju, manjkalo je 287 zuba u 149 osoba muškoga spola te 384 zuba u 196 osoba ženskoga spola, što pokazuje sličnu zahvaćenost između spolova – OR = 0,98 (95 % CI, 0,76 do 1,28). Mandibularni zubi značajno su češće zahvaćeni od maksilarnih – 191 (66,6 %) prema 96 (33, 4 %) [OR = 1,99 (95 % CI, 1,48 to 2,67)] kod muškaraca i 246 (64,1%) prema 138 (35,9%) [OR = 1,78 (95 % CI, 1,39 do 2,29)] u žena, bez statistički značajne razlike između spolova. Između 287 zuba koji nedostaju ispitanicima, najčešće su manjkali zub 35 (28,5 %), zatim 45 (26,7 %), 12 (9,0 %), 22 (8,3 %), 15 i 25 (6,3 %). Osam različitih zuba nije nedostajalo. Između 384 zuba, ispitanicama je najčešće nedostajao zub 35 (26,3 %), zatim 45 (24,0 %), 25 (8,9 %), 15 (8,6 %), 22 (8,3 %) i 12 (7,3%). Šest različitih zuba nije nedostajalo (tablica 3.).

study sample for further analysis, separately for males and females.

In total, the prevalence of CMPT in tested sample was higher in females (9.2%) when compared to males (6.5%), OR = 1.42 (95% CI, 1.14 to 1.77), (p=0.002). Mild, moderate and severe CMPT were similarly distributed between males and females, without statistically significant difference. The prevalence of 1 missing permanent tooth was 66 (44.3%) in males and 83 (42.3%) in females, while of 2 teeth was 56 (37.6%) in males and 75 (38.3%) in females. Bilateral hypodontia of lower second premolars and upper second incisors was more common than unilateral hypodontia. Additionally, moderate CMPT, or subjects with 3, 4 or 5 missing permanent teeth, were 11 (7.4%), 10 (6.7%) and 4 (2.7%) in males and 15 (7.7%), 16 (8.2%) and 4 (2.0%) respectively. Severe CMPT or oligodontia was distributed as follows: 6 missing teeth were found in 2 females, eight missing teeth in 2 males, and finally, 11 missing teeth in single male (Table 2).

In total, 287 and 384 missing teeth were found in 149 males and 196 females, respectively, indicating similar affection between sexes, OR = 0.98 (95% CI, 0.76 to 1.28). The mandibular teeth were significantly more affected than maxillary, 191 (66.6%) vs. 96 (33.4%), OR = 1.99 (95% CI, 1.48 to 2.67) and 246 (64.1%) vs. 138 (35.9%), OR = 1.78 (95%CI, 1.39 to 2.29) in males and females respectively, without significant difference between genders. Amongst 287 missing teeth in males, the most commonly missing were teeth No. 35 (28.5 %), followed by No. 45 (26.7%), No.12 (9.0%), No. 22 (8.3%), No. 15 and No. 25 (6.3%). Eight different teeth were not missing. Amongst 384 missing teeth in females, the most frequently missing tooth was No. 35 (26.3 %), followed by No. 45 (24.0%), No. 25 (8.9%), No. 15 (8.6%), No. 22 (8.3%) and No. 12 (7.3%). Six different teeth were not missing (Table 3).

www.ascro.hr

Tablica 2. Raspodjela zuba koji nedostaju prema poziciji u zubnom luku prema FDI-ju u slučaju blage, umjerene i teške hipodoncije
Table 2 Distribution by the position in the mouth and frequency of specific congenitally permanent missing teeth (CMPT) according to the World Dental Federation (FDI) notation in mild, moderate and severe hypodontia in evaluated sample

No. (FDI)	Muškarci • Males	Žene • Females	Ukupno • Total	No.(FDI)	Muškarci • Males	Žene • Females	Ukupno • Total
blaga hipodoncija – 1 ili 2 zuba • Mild hypodontia, 1 or 2 teeth				**15, 25, 45**	-	2	2
12	6	4	10	**15, 34, 45**	-	1	1
15	4	4	8	**15, 35, 45**	1	-	1
22	4	7	11	**22, 34, 44**	-	1	1
25	1	2	3	**22, 35, 45**	1	1	2
31	2	1	3	**25, 35, 47**	1	-	1
35	23	34	57	**25, 35, 45**	-	3	3
37	1	2	3	**32, 35, 42**	-	1	1
41	1	0	1	**32, 37, 42**	-	1	1
42	1	2	3	**34, 35, 45**	2	-	2
44	1	0	1	**35, 44, 45**	2	-	2
45	17	28	45	**44, 45, 46**	1	-	1
47	5	-	5	**12, 22, 32, 42**	-	1	1
12, 22	11	12	23	**12, 22, 25, 45**	-	1	1
12, 45	1	1	2	**12, 22, 35, 45**	2	3	5
15, 25	1	6	7	**15, 25, 32, 42**	-	1	1
15, 37	-	1	1	**15, 25, 35, 45**	6	7	13
15, 45	1	2	3	**12, 15, 25, 45**	1	-	1
22, 25	1	-	1	**12, 15, 22, 25**	-	2	2
25,35	1	4	5	**27, 31, 41, 47**	-	1	1
25, 45	1	-	1	**27, 31, 37, 47**	1	-	1
31, 35	1	-	1	**12, 22, 15, 35, 45**	-	1	1
31, 41	1	-	1	**12, 22, 25, 35, 45**	1	-	1
32, 42	1	2	3	**12, 22, 35, 37, 47**	1	-	1
33, 43	-	2	2	**13, 17, 27, 37, 47**	-	1	1
35, 42	1	-	1	**14, 15, 25, 35, 45**	1	-	1
35, 45	35	38	73	**15, 24, 25, 35, 45**	1	-	1
35, 47	-	1	1	**17, 27, 35, 45, 47**	-	1	1
37, 47	-	4	4	**27, 31, 37, 41, 47**	-	1	1
37, 45	-	1	1				
				Teška hipodoncije, 6 i više zuba • Severe hypodontia, 6 and more teeth			
Umjerena hipodoncija - od 3 do 5 zuba • Moderate hypodontia 3 to 5 teeth				**14, 15, 24, 25, 35, 45**	-	1	1
12, 22, 24	-	1	1	**15, 23, 25, 35, 44, 45**	-	1	1
12, 22, 35	1	1	2	**13, 14, 15, 24, 25, 35, 44, 45**	1	-	1
12,22, 45	2	-	2	**14, 15, 17, 24, 25, 27, 37, 47**	1	-	1
15, 25, 35	-	3	3	**31, 34, 35, 22, 25, 12, 15, 41, 44, 45, 47**	-	1	1
Ukupno • Total					149	196	345

Rasprava

Naši rezultati prevalencije hipodoncije od 6,5 posto u muških i 9,2 posto u ženskih ispitanika ili 7,8 posto kod oba spola, pokazali su se kao jedni od najvećih u Europi. Najbliži su onima koje je objavio Rølling (23) za devetogodišnju i desetogodišnju školsku djecu u Danskoj (7,8 %) i Magnusson (24) za djecu u dobi od 8 do 18 godina iz Reykjavika na Islandu (7,9 %). U svojoj metaanalizi od ukupno 40 istraživanja prevalencije hipodoncije, Khalaf i suradnici (15) izračunali su prevalenciju u 95-postotnom rasponu pouzdanosti od 6,0 do 8,0 posto. Naši rezultati prevalencije hipodoncije za ženske ispitanike te najčešća zahvaćenost drugih donjih

Discussion

Our findings of the prevalence of CMPT, 6.5% and 9.2% in males and females, respectively, or 7.8% for both genders, showed one of the highest prevalences in Europe. Our results are closest to those reported by Rølling (23) for Danish school children (7.8%) and study by Magnusson (24) from Iceland (7.9%). Khalaf et al. in their meta-analysis of 40 studies (15) reported 95% CI prevalence of 6.0 - 8.0%. Higher prevalence of congenitally missing permanent teeth in females and the highest affection of the lower second premolars following upper lateral incisors and upper second premolars followed the pattern of distribution of specific teeth in

www.ascro.hr

Tablica 3. Broj i postotak pojedinih trajnih zuba koji nedostaju u istraženom uzorku prema poziciji u zubnom luku – označeno prema FDI-ju
Table 3 Frequency and percentage (%) of specific congenitally missing permanent teeth (CMPT) in an evaluated sample by the position in the mouth according to the World Dental Federation (FDI) notation to a specific tooth.

Zub • Tooth (FDI)	Muškarci • Males	Žene • Females	Ukupno • Total
11	- (0.0)	- (0.0)	- (0.0)
12	26 (9.4)	28 (7.3)	56 (8.2)
13	1 (0.3)	1 (0.3)	2 (0.3)
14	3 (1.0)	1 (0.3)	4 (0.6)
15	18 (6.3)	33 (8.6)	51 (7.6)
16	- (0.0)	- (0.0)	- (0.0)
17	1 (0.3)	2 (0.5)	3 (0.4)
21	0 (0.0)	1 (0.3)	1 (0.1)
22	24 (8.3)	31 (8.1)	55 (8.2)
23	0 (0.0)	1 (0.3)	1 (0.1)
24	3 (1.0)	2 (0.5)	5 (0.7)
25	18 (6.3)	34 (8.9)	52 (7.7)
26	- (0.0)	- (0.0)	- (0.0)
27	2 (0.7)	4 (1.0)	6 (0.9)
31	5 (1.7)	4 (1.0)	9 (1.3)
32	1 (0.3)	6 (1.6)	7 (1.0)
33	0 (0.0)	2 (0.5)	2 (0.3)
34	2 (0.7)	3 (0.8)	5 (0.8)
35	82 (28.5)	101 (26.3)	183 (27.2)
36	- (0.0)	- (0.0)	- (0.0)
37	4 (1.4)	11 (2.9)	15 (2.2)
41	2 (0.7)	3 (0.8)	5 (0.7)
42	3 (1.0)	8 (2.1)	11 (1.6)
43	0 (0.0)	2 (0.5)	2 (0.3)
44	5 (1.7)	3 (0.8)	8 (1.2)
45	77 (26.7)	93 (24.2)	170 (25.3)
46	1 (0.3)	0 (0.0)	1 (0.1)
47	9 (3.1)	10 (2.6)	19 (2.8)
Ukupno • Total	288 (100.0)	384 (100.0)	672 (100.0)

pretkutnjaka, zatim drugih gornjih sjekutića i drugih gornjih pretkutnjaka, u rasponu su objavljenih rezultata i raspodjele specifičnih zuba u hipodonciji kao u većini drugih istraživanja (13 – 15).

Naši rezultati također su unutar raspona prevalencije hipodoncije trajnih zuba u već objavljenim istraživanjima iz Hrvatske – u rasponu od 2,32 posto u istraživanju Miličića i Čanka (21) do 7,99 posto u istraživanju Miličića i suradnika (20). Bioarheološka istraživanja ortodontskih anomalija iz Hrvatske pokazala su pojavnost hipodoncije od 41,02 posto u kasnoj antici i 30,61 posto u ranom srednjem vijeku (25, 26). Prije objavljeni radovi o prevalenciji hipodoncije iz Hrvatske variraju u veličini uzorka i rasponu dobi istražene kohorte. Miličić i Čanak (21), u istraživanju na ortodontskim pacijentima u dobi od 7 do 21 godine na Sveučilištu u Zagrebu tijekom 1975., također su pronašli da su drugi donji pretkutnjaci bili najzahvaćeniji hipodoncijom, zatim slijede drugi gornji sjekutići i drugi gornji pretkutnjaci, s većom prevalencijom u žena. Također su pronašli sličnu zahvaćenost u obje čeljusti, što nije bio slučaj u ovom istraživanju (21). Visković i suradnici (19) u svojoj su studiji hipodoncije iz grada Zadra u sjevernoj Dalmaciji, u uzorku ortodontskih pacijenata u dobi od

CMPT from other studies (13-15).

Our results are also within range of prevalence of CMPT reported in previous studies from Croatia, range from 2.32% in the study by Miličić and Čanak (21) up to 7.99% in the study by Miličić et al. (20) originating from the 20th century. Bioarchaeological investigations of orthodontic anomalies from Croatia reported up to 41.02% and 30.61% of CMPT prevalence in Late Antiquity and Early Medieval periods, respectively (25, 26). Reports of CMPT from Croatia vary in sample size and age cohorts. Miličić and Čanak (21) in their study on orthodontic patients age 7-21 years from the University of Zagreb in 1975, also found that second mandibular premolars were the most affected teeth, followed by the upper lateral incisors and upper second premolars, with higher prevalence in females. They found similar affection in both jaws (21) which was not the case in our study. Visković et al. (19) in their research from the city of Zadar in Northern Dalmatia, found a CMPT prevalence of 5.52% in the sample of orthodontic patients 8 - 20 years of age. They also found a slightly higher prevalence of CMPT in females than in males, with higher prevalence in the maxilla. The most affected teeth were upper lateral incisors followed by the mandibular sec-

www.ascro.hr

8 do 20 godina, pronašli prevalenciju od 5,52 posto. Pronašli su i veću prevalenciju hipodoncije kod žena, i s većom prevalencijom u maksili. Općenito, najzahvaćeniji zub bio je drugi gornji sjekutić, zatim drugi mandibularni pretkutnjak, a u našem istraživanju najzahvaćeniji zubi bili su drugi mandibularni pretkutnjaci. Najzahvaćeniji je zub 22 (17,12 %), a zatim slijedi 35. Još jedno retrospektivno istraživanje, iz 1994. godine na Sveučilišta u Zagrebu, analiziralo je desetogodišnji uzorak ortodontskih pacijenata u dobi između među 6 i 18 godina i pokazalo je srednju prevalenciju hipodoncije od 7,99 (17). Miličić i suradnici (20) pronašli su veću zahvaćenost drugih gornjih sjekutića (41,5 %) zatim drugih donjih (34,12 %) i gornjih (18,69 %) pretkutnjaka. Istraživanje Legovića i suradnika (17) o prevalenciji hipodoncije u ortodontskih pacijenata od 6 do 18 godina u dvjema hrvatskim regijama – Slavoniji i Istri, pokazalo je značajno veću hipodonciju u Istri (6,25 %) u usporedbi sa Slavonijom (2,34 %). Manjak trajnih zuba u mandibuli prevladavao je među djecom u Istri, a u maksili je prevladavao u djece u Slavoniji (17).

U našoj studiji je dvije trećine trajnih zuba koji nedostaju zahvaćalo mandibulu, a nedavna metaanaliza Khalafa i suradnika pokazala je podjednaku raspodjelu hipodoncije u obje čeljusti (15).

Uzorak snimaka za ovu studiju pribavljen je od pacijenata koji su pregledani u šest specijalističkih ortodontskih ordinacija tijekom navedenog razdoblja u trima urbanim područjima u južnoj Hrvatskoj. Time se željelo prikladnije predstaviti ciljanu populaciju kako bi se eventualno pronašla razlika između urbanih područja. Općenito, preventivni, restaurativni i interceptivni ortodontski zahvati besplatno su dostupni svim hrvatskim državljanima do punoljetnosti ili do dobi od 18 godina (27). Teška stanja i klinički slučajevi koji zahtijevaju napredniji, multidisciplinarni i dugoročni tretman obrađuju se u nacionalnom referentnom centru za oralnu i maksilofacijalnu kirurgiju i patologiju (Sveučilišna bolnica Dubrava, Zagreb, Hrvatska), ili u referentnim centrima za specifična stanja i sindrome u Europskoj uniji. Zbog toga je ciljani uzorak uključio samo one pacijente bez pojedinih nasljednih stanja i sindroma povezanih s hipodoncijom. Broj slučajeva s hipodoncijom u ovim regijama – uključuju jedan ili dva zuba koji nedostaju – mogao bi biti i veći, a razlog tomu jest to što opći stomatolog u dogovoru s pacijentima i njihovim roditeljima odlučuje da se ne upućuju na ortodontski pregled i terapiju (28). Sustavni pregled i metaanaliza Khalafa i suradnika iz 2014. (15) postavljeni su kao referencija za usporedbu prevalencije u našem istraživanju. Naš je glavni rezultat da je prevalencija hipodoncije među najvećima u dosad objavljenim istraživanjima u Europi (15). Starija metaanaliza Poldera i suradnika iz 2004. godine (13), iz koje su bili isključeni ortodontski pacijenti, pokazala je veliku varijaciju u prevalenciji hipodoncije – od 0,3 posto u izraelskoj školskoj populaciji u gradu Jeruzalemu (objavili su Rosenzweig i Gabarski) (29), pa sve do 36,5 posto u religiozno i genetski izoliranih Dariusleut Hutterita u zapadnoj Kanadi (objavili su Mahaney i suradnici) (30). Većina istraživanja ne može se izravno usporediti zbog različitih metoda uzorkovanja i zapažanja, raspona dobi i spola, uključujući i nasljedne te okolišne čimbenike (15). Khalaf i suradnici (15) pokazali su da je

ond premolars, while in our study the most affected teeth were mandibular second premolars. The most affected were tooth No. 22 (17.12%), followed by tooth No. 35. Another retrospective study, which was conducted in 1994 at the University of Zagreb, included orthodontic patients aged 6-18 years during previous ten years, reported CMPT prevalence of 7.99% (20). Miličić et al. (20) found higher affection of upper lateral incisors (41.5%) followed by lower (34.12%) and higher (18.69%) second premolars. Investigation of the prevalence of CMPT on 6 - 18-year-old orthodontic patients in two other Croatian regions, Slavonia and Istria, by Legović et al. (17), showed significantly higher CMPT in Istria (6.25%) than in Slavonia (2.34%). CMPT in the mandible prevailed among the children from Istria, while that in the maxilla among the children in Slavonia (17). Two-thirds of the missing teeth in our study were located in the maxilla, while recent meta-analyses by Khalaf et al. (15) reported similar distribution between jaws.

The sample for this study was recruited from patients who attended six different orthodontics practices during a specific period, in three different urban zones in Southern Croatia, to represent target population of orthodontic patients more appropriately and to detect a different pattern among regions. Preventive and restorative dental and interceptive orthodontic treatments are available and free of charge to all Croatian residents under the age of 18 years (27). More severe conditions, syndromes, and cases that require more advanced, multidisciplinary and long-term treatment, are commonly referred to oral and maxillofacial national reference hospital (University Hospital Dubrava, Zagreb, Croatia), or to reference centers for specific conditions or syndromes in the European Union. For that reason, the target sample included only participants without hereditary conditions or syndromes correlated with CMPT. The number of mild cases involving one or two missing teeth may be even higher because of general dentists' decisions and agreement with the patient and their parents not to treat CMPT or refer their patient to orthodontic evaluation and sophisticated treatment (28). Previous systematic review and meta-analysis from 2014 by Khalaf et al. (15) was set as a reference to compare prevalence from this study. Our main finding of CMPT prevalence is among highest reported for studies in Europe (15). Older meta-analysis of prevalence of CMPT from 2004 by Polder et al. (13), which excluded orthodontic patients, reported considerable variation in prevalence of CMPT, from 0.3% in the Israeli population of grade school children in Jerusalem, reported by Rosenzweig and Gabarski (29), to 36.5% in the Dariusleut Hutterites of Western Canada, reported by Mahaney et al. (30). It is difficult to compare the studies because of different methods of sampling and observation, age range, sex, including hereditary or environmental factors (15). Khalaf et al. (15) showed that recent studies reported a higher prevalence of hypodontia if compared to the previous meta-analysis by Polder et al. (13), which may be attributed to better diagnostics and inclusion of more prevalence studies. Polder *et al.* (13) in their meta-analysis excluded studies with orthodontic patients which are more interested in orthodontic evaluation and possible treatment with a chance to be recog-

www.ascro.hr

u novijim istraživanjima uočena veća prevalencija hipodoncije u usporedbi s prijašnjom metaanalizom Poldera i suradnika (13), što se može pripisati boljoj dijagnostici i uključivanju većeg broja istraživanja. Polder i suradnici (13) isključili su u svojoj metaanalizi istraživanja hipodoncije kod ortodontskih pacijenata koji su sigurno zanimljiviji u ortodontskoj dijagnostici i mogućoj terapiji, što povećava mogućnost da se hipodoncija prepozna i zabilježi. Khalaf i suradnici (15) nisu pronašli statistički značajnu razliku u prevalenciji hipodoncije između ortodontskih pacijenata i ostalih populacijskih skupina. U našem istraživanju pronašli smo značajno veću prevalenciju hipodoncije u ženskih ispitanika, što je u skladu s metaanalizama Poldera i suradnika (13) te Khalafa i njegovih suradnika (15), a Mattheeuws i suradnici (14) nisu pronašli značajnu razliku između spolova.

U našem je istraživanju prevalencija hipodoncije u mandibuli bila gotovo dva puta veća negoli u maksili, a prijašnje su metaanalize pokazale podjednaku zahvaćenost obiju čeljusti (13, 15). Ustanovili smo da je drugi donji pretkutnjak bio najzahvaćeniji zub hipodoncijom u oba spola, zatim drugi gornji sjekutići u muškaraca i drugi gornji pretkutnjaci u žena. Gornji središnji sjekutići i gotovo svi prvi kutnjaci nisu bili zahvaćeni hipodoncijom. Naši rezultati u skladu su s prijašnjim metaanalizama prevalencije i raspodjele specifičnih zuba zahvaćenih hipodoncijom Poldera i suradnika (13) te Khalafa i suradnika (15). Nastanjenost u specifičnom geografskom području, uključujući priobalje i kontinentalni dio, nije utjecala na prevalenciju hipodoncije u oba spola, što upućuje na podjednaku zahvaćenost ispitanika hipodoncijom unutar regije. Behr i suradnici (1) pokazali su statistički značajnu razliku u prevalenciji hipodoncije u njemačkome gradu Regensburgu i njegovoj okolici. Drugo istraživanje prevalencije hipodoncije u različitim regijama u Turskoj, koje su obavili Aktan i suradnici (18), pokazalo je statistički značajnu razliku između šest regija.

Odgovarajuće vrijeme optimalne ortodontske terapije ovisi o lokalizaciji i brojnosti trajnih zuba koji nedostaju, dobi, skeletnim i dentalnim karakteristikama pacijenta te financijskoj mogućnosti i motivaciji pacijenta (31, 32). Izazovi u terapiji pacijenata s hipodoncijom uključuju dobivanje raspoloživog prostora, poravnavanje zuba, duboki preklop i konačnu retenciju (33). Prateća mikrodoncija susjednih ili istovrsnih zuba u slučaju jednostrane hipodoncije, zadržani mliječni zubi i prateći poremećaj nicanja i pozicija zuba nasljednika, utječu na raspoloživ prostor u luku (34).

Klinička odluka je li cilj terapije zatvaranje prostora ili otvaranje s ugradnjom dentalnog implantata ili drugi restaurativni zahvat, zahtijeva planiranje terapije utemeljene na dokazima (31). Interdisciplinarni pristup i suradnja ortodonta i drugih specijalista – protetičara, parodontologa, specijalista restaurativne dentalne medicine i endodoncije te oralnoga kirurga – preduvjet je za optimalni rezultat u terapiji hipodoncije.

Zaključak

Naši rezultati nisu pokazali razliku u prevalenciji hipodoncije u različitim urbanim područjima u južnoj Hrvatskoj.

nized and recorded. Khalaf et al. (15) also found no statistically significant differences in the prevalence of CMPT between orthodontic patients and other population types. We found a significantly higher prevalence of CMPT in females than in males which are in general agreement with meta-analyses by Polder et al. (13) and Khalaf et al. (15), while Mattheeuws et al. (14) found no differences between genders.

In our study, the prevalence of CMPT in the mandible was almost two-fold higher than in the maxilla, while previous meta-analyses reported similar affection of both jaws (13, 15). Also, we found that the lower second premolars were most affected teeth in both genders, followed by the upper second incisors in males and upper second premolars in females. Upper central incisors and almost all first molars were not affected. Our findings are in agreement with previous meta-analyses of prevalence and distribution of specific teeth of CMPT by Polder et al. (13) and Khalaf et al. (15). Specific geographic regions, including littoral and continental, did not affect the prevalence of CMPT in both genders, which indicates similar affection in the whole region. Behr et al. (1) reported significantly different prevalence in the city of Regensburg and regions outside Regensburg, Germany. Another geographically oriented study by Aktan et al. (18) showed significant difference among six areas in Turkey.

The appropriate timing for the optimal orthodontic treatment approach depends on the localization and number of congenitally missing teeth, age, skeletal and dental characteristics of the patient as well as available finances and patient motivation (31, 32). Clinical problems faced in treating CMPT patients embrace amount of space, aligning teeth, deep overbite and the final retention (33). The joint microdontia of adjacent teeth, retaining deciduous teeth, and the abnormal eruptive paths and drifting of the successional teeth influence the amount of space (34). The clinical decision whether the plan includes space closure with eventual teeth reshaping or space opening with subsequent placement of dental implants or other restorative treatment needs evidence-based treatment planning (31). The interdisciplinary approach and interaction between the orthodontist and other specialists such as prosthodontists, periodontists, endodontists, restorative dentists and oral surgeons are essential for an optimal therapeutic outcome.

Conclusion

Our findings showed a similar prevalence of CMPT in different urban zones in Southern Croatia. The most com-

www.ascro.hr

Zubi koji su najčešće nedostajali bili su drugi mandibularni pretkutnjaci, zatim drugi maksilarni pretkutnjaci u žena i drugi gornji sjekutići u muškaraca. Pojava obostrane hipodoncije drugih donjih pretkutnjaka i drugih gornjih sjekutića češća je od jednostrane. Broj zuba koji nedostaju i izraženost hipodoncije bili su u rasponu rezultata objavljenih u prijašnjim istraživanjima u Hrvatskoj i Europi. Buduća državna i regionalna epidemiološka istraživanja mogu pridonijeti boljem razumijevanju mogućih geografskih varijacija u prevalenciji hipodoncije, što može poboljšati ukupni terapeutski pristup.

monly missing permanent teeth were mandibular second premolars followed by the maxillary upper second premolars in females and upper second incisors in males. The occurrence of bilateral hypodontia of lower second premolars and upper second incisors are more common than unilateral hypodontia. The quantity of missing teeth and severity of hypodontia was within the range reported in previous studies across Croatia and Europe. Further national and regional epidemiological studies may attribute to understand better possible geographic variations in the prevalence of CMPT which may improve the therapeutic approach.

The high prevalence of CMPT in Southern Croatia reinforces the need for a timely diagnostics. In view of the high prevalence of CMPT in Southern Croatia, it is suggested that treatment of moderate and severe cases needs to be initiated.

Sukob interesa

Autori izjavljuju da nema sukoba interesa.

Conflict of interest

The authors declare no conflict of interest.

Zahvala

Autori zahvaljuju svim doktorima i asistentskom osoblju za pomoć u pretraživanju baza podataka te medicinske dokumentacije te prof. dr. sc. Ani Marušić za pomoć pri izradi teksta.

Acknowledgement

The authors would like to express their thanks to all doctors and associated staff for their help in searching databases and medical and radiography records and to Professor Ana Marušić for her help in preparing the manuscript.

Abstract

Background: Congenitally missing permanent teeth (CMPT), excluding third molars, was recognized as a clinical and public health problem in pediatric dentistry. **Aim:** To determine the prevalence of CMPT among orthodontic patients in Southern Croatia. **Materials and Methods:** In a retrospective study, we analyzed CMPT in patients from three different regions in Southern Croatia (SC). Two orthodontic practices from each region were selected and a total of 4649 records of patients aged 6 - 15 years, who were clinically examined for orthodontic treatment between 2008 and 2015, were evaluated. We excluded 219 patients and 4430 patients remained for further analysis. **Results:** There was no difference in prevalence of CMPT among regions in Southern Croatia, and the whole sample was evaluated. CMPT was found in 345(7.8%) patients. The highest proportion of CMPT was with one or two missing teeth 122 (81.9%) and 158 (80.6%), followed by those with three to five missing teeth or moderate hypodontia, 25(16.8%) and 35(17.9%), in males, and females respectively. Bilateral hypodontia of the lower second premolars and upper second incisors was more common than unilateral hypodontia. **Conclusions:** The obtained results of high prevalence of CMPT in Southern Croatia reinforce the need for a timely diagnostics and treatment of moderate and severe cases.

Received: August 8, 2017
Accepted: October 16, 2017

Address for correspondence
Assistant Professor Ivan Galić, DMD, PhD,
University of Split
School of Medicine
Soltanska 2, 21000 Split, Croatia.
Tel: 385-99-69-64-609;
i_galic@yahoo.com

Key words
Anodontia; Prevalence, Croatia

References

1. Behr M, Proff P, Leitzmann M, Pretzel M, Handel G, Schmalz G, et al. Survey of congenitally missing teeth in orthodontic patients in Eastern Bavaria. Eur J Orthod. 2011 Feb;33(1):32-6.
2. Visinoni AF, Lisboa-Costa T, Pagnan NA, Chautard-Freire-Maia EA. Ectodermal dysplasias: clinical and molecular review. American journal of medical genetics Part A. Am J Med Genet A. 2009 Sep;149A(9):1980-2002.
3. Celikoglu M, Buyuk SK, Sekerci AE, Cantekin K, Candirli C. Maxillary dental anomalies in patients with cleft lip and palate: a cone beam computed tomography study. The Journal of clinical pediatric dentistry. Am J Orthod Dentofacial Orthop. 2016 Oct;150(4):564-574.
4. The relationship between craniofacial development and hypodontia in patients with Down syndrome. European journal of orthodontics. Eur J Orthod. 2016 Apr;38(2):178-83.
5. Abdalla EM, Mostowska A, Jagodzinski PP, Dwidar K, Ismail SR. A novel WNT10A mutation causes non-syndromic hypodontia in an Egyptian family. Arch Oral Biol. 2014 Jul;59(7):722-8.
6. Pawlowska E, Janik-Papis K, Poplawski T, Blasiak J, Szczepanska J. Mutations in the PAX9 gene in sporadic oligodontia. Orthodontics & craniofacial research. Orthod Craniofac Res. 2010 Aug;13(3):142-52.
7. Andersson EM, Axelsson S, Austeng ME, Overland B, Valen IE, Jensen TA, et al. Bilateral hypodontia is more common than unilateral hypodontia in children with Down syndrome: a prospective population-based study. European journal of orthodontics. Orthod Craniofac Res. 2010 Aug;13(3):142-52.
8. Dreesen K, Swinnen S, Devriendt K, Carels C. Tooth agenesis patterns and phenotype variation in a cohort of Belgian patients with hypodontia and oligodontia clustered in 79 families with their pedigrees. Eur J Orthod. 2014 Feb;36(1):99-106.
9. Hvaring CL, Ogaard B, Stenvik A, Birkeland K. The prognosis of retained primary molars without successors: infraocclusion, root resorption and restorations in 111 patients. Eur J Orthod. 2014 Feb;36(1):26-30.
10. Aktan AM, Kara I, Sener I, Bereket C, Celik S, Kirtay M, et al. An evaluation of factors associated with persistent primary teeth. Eur J Orthod. 2012 Apr;34(2):208-12.
11. Zebrowitz LA, Montepare JM. Social Psychological Face Perception: Why Appearance Matters. Social and personality psychology compass. Soc Personal Psychol Compass. 2008 May 1;2(3):1497.
12. Murdock S, Lee JY, Guckes A, Wright JT. A costs analysis of dental treatment for ectodermal dysplasia. Journal of the American Dental Association. J Am Dent Assoc. 2005 Sep;136(9):1273-6.

13. Polder BJ, Van't Hof MA, Van der Linden FP, Kuijpers-Jagtman AM. A meta-analysis of the prevalence of dental agenesis of permanent teeth. Community dentistry and oral epidemiology. Community Dent Oral Epidemiol. 2004 Jun;32(3):217-26.
14. Mattheeuws N, Dermaut L, Martens G. Has hypodontia increased in Caucasians during the 20th century? A meta-analysis. European journal of orthodontics. Eur J Orthod. 2004 Feb;26(1):99-103.
15. Khalaf K, Miskelly J, Voge E, Macfarlane TV. Prevalence of hypodontia and associated factors: a systematic review and meta-analysis. Journal of orthodontics. J Orthod. 2014 Dec;41(4):299-316.
16. Sisman Y, Uysal T, Gelgor IE. Hypodontia. Does the prevalence and distribution pattern differ in orthodontic patients? Eur J Dent. 2007 Jul;1(3):167-73.
17. Legovic M, Ceranic I, Cehich A. [Anomalies in the number of permanent teeth in orthodontic patients in 2 localities in Croatia]. Schweiz Monatsschr Zahnmed. 1990;100(3):286-90.
18. Aktan AM, Kara IM, Şener İ, Bereket C, Ay S, Çiftçi ME. Radiographic study of tooth agenesis in the Turkish population. Oral Radiol. 2010;26(2):95-100.
19. Viskovic R, Jursic A, Cmelnik N. [Hypodontia--prevalence and variations in orthodontic patients]. Acta Stomatol Croat. 1988;22(1):23-30.
20. Miličić A, Gaži-Čoklica V, Lapter M. Developmental anomalies of genetically instable teeth. Acta Stomatol Croat. 1994;28:271-9.
21. Miličić A, Čanak V. Hypodontia and accompanying phenomena. Acta Stomatol Croat. 1975;9:133-40.
22. Ostroški L. Statistical yearbook of the Republic of Croatia. Zagreb: Croatian Bureau of Statistics; 2013.
23. Rolling S. Hypodontia of permanent teeth in Danish schoolchildren. Scandinavian journal of dental research. Scand J Dent Res. 1980 Oct;88(5):365-9.
24. Magnusson TE. Prevalence of hypodontia and malformations of permanent teeth in Iceland. Community dentistry and oral epidemiology. Community Dent Oral Epidemiol. 1977 Jul;5(4):173-8.
25. Vodanovic M, Galic I, Strujic M, Peros K, Slaus M, Brkic H. Orthodontic anomalies and malocclusions in Late Antique and Early Mediaeval period in Croatia. Arch Oral Biol. 2012 Apr;57(4):401-12.
26. Barac-Furtinovic V, Skrinjaric I. [Double teeth in primary dentition and findings of permanent successors]. Acta Stomatol Croat. 1991;25(1):39-43.
27. Galic I, Lauc T, Brkic H, Vodanovic M, Galic E, Biazevic MG, et al. Cameriere's third molar maturity index in assessing age of majority. Forensic Sci Int. 2015 Jul;252:191.e1-5.
28. Behr M, Driemel O, Mertins V, Gerlach T, Kolbeck C, Rohr N, et al. Concepts for the treatment of adolescent patients with missing permanent teeth. Oral Maxillofac Surg. 2008 Jul;12(2):49-60.
29. Rosenzweig KA, Garbarski D. Numerical aberrations in the permanent teeth of grade school children in Jerusalem. Am J Phys Anthropol. 1965 Sep;23(3):277-83.
30. Mahaney MC, Fujiwara TM, Morgan K. Dental agenesis in the Dariusleut Hutterite Brethren: comparisons to selected Caucasoid population surveys. American journal of physical anthropology. Am J Phys Anthropol. 1990 Jun;82(2):165-77.
31. Al-Ani AH, Antoun JS, Thomson WM, Merriman TR, Farella M. Hypodontia: An Update on Its Etiology, Classification, and Clinical Management. Biomed Res Int. 2017;2017:9378325.
32. Badrov J, Lauc T, Nakas E, Galic I. Dental Age and Tooth Development in Orthodontic Patients with Agenesis of Permanent Teeth. Biomed Res Int. 2017;2017:8683970.
33. Carter NE, Gillgrass TJ, Hobson RS, Jepson N, Eechan JG, Nohl FS, et al. The interdisciplinary management of hypodontia: orthodontics. Br Dent J. 2003 Apr 12;194(7):361-6.
34. Hobkirk, JA; Gill, DS; Jones, SP - editors. Hypodontia A Team Approach to Management: London: Wiley –Blackwell; 2011.